

WHAT IS CLAIMED IS:

1. An apparatus comprising:
  - (a) a substrate mount for receiving a substrate,
  - 5 (b) a dispensing device for dispensing reagents for synthesizing a biopolymer on a surface of said substrate, and
  - (c) an optical system for positioning said substrate mount along said y-axis and an optical system for positioning said dispensing device along said x-axis, said optical systems cooperating to position said substrate mount and said dispensing device
  - 10 relative to one another,wherein one of said substrate mount and said dispensing device is adapted for translation along a y-axis and for rotation about a central axis of the substrate mount that is parallel to a z-axis, and the other of said substrate mount and said dispensing device is adapted to move along an x-axis transversely to the direction of movement of said one.
- 15 2. An apparatus according to Claim 1 further comprising a touch system for positioning said substrate and said dispensing device along a z-axis.
3. An apparatus according to Claim 1 wherein said optical system for
- 20 positioning said substrate mount comprises at least one image sensor and said substrate comprises at least one target image for imaging by said image sensor.
4. An apparatus according to Claim 1 wherein said apparatus further comprises a calibration system, said optical systems and said calibration system
- 25 cooperating to position said substrate mount along said y-axis and said dispensing device along said x-axis.
5. An apparatus according to Claim 4 wherein said calibration system comprises a locator device having a predetermined fixed target location and a camera
- 30 acting in cooperation with said optical systems.
6. An apparatus according to Claim 2 wherein said substrate mount is adapted such that its orientation is adjusted to align said substrate along said y-axis as a

result of input from said optical system for positioning said substrate mount and wherein said dispensing device is adapted such that its orientation is adjusted to align said dispensing device along said x-axis as a result of input from said optical system for positioning said dispensing device.

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7. An apparatus according to Claim 6 wherein said optical systems communicate with a computer, which provides input from said optical systems to said substrate mount and to said dispensing device and said touch system communicates with said computer.

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8. An apparatus according to Claim 1 further comprising a delivery device for delivering said substrate to said substrate mount, said delivery device having associated therewith a delivery device optical system for positioning said substrate to be within the field of view of the said support mount optical system.

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9. An apparatus according to Claim 8 wherein said delivery device optical system comprises at least one image sensor and said substrate comprises at least one target images for imaging by said image sensor.

20 10. An apparatus for synthesizing a plurality of biopolymer features on the surface of a substrate, said apparatus comprising:

(a) a substrate mount for receiving a substrate, said substrate mount being adapted for translation along an y-axis and for rotation about a central axis of the substrate mount that is parallel to a z-axis,

25 (b) a dispensing device for dispensing reagents for synthesizing biopolymers on a surface of said substrate wherein said dispensing device moves transversely with respect to said substrate mount,

(c) an optical system for positioning said substrate mount along said y-axis and an optical system for positioning said dispensing device along said x-axis, said  
30 optical systems cooperating to position said substrate mount and said dispensing device relative to one another,

(d) a touch system for positioning said substrate and said dispensing device along a z-axis,

- (e) a loading station for loading said reagents into said dispensing device,
- (f) a mechanism for moving said dispensing device and/or said loading station relative to one another,
- (g) a wash station for washing said dispensing device, and
- 5 (h) a mechanism for moving said dispensing device and/or said wash station relative to one another.

11. An apparatus according to Claim 10 further comprising an inspection device for inspecting the reagents dispensed to the surface of said substrate.

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12. An apparatus according to Claim 10 wherein said wash station comprises:

- (a) a plurality of receptacles for sealingly engaging each head comprising said nozzles, said receptacles containing a wash solution,

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- (b) a wet wash pad for engaging a surface comprising said nozzles,

- (c) a dry pad for engaging said surface, and

- (d) a mechanism for moving said nozzles from said plurality of receptacles to said wet wash pad and then to said dry pad.

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13. An apparatus according to Claim 10 wherein said optical system for positioning said substrate mount comprises two or more image sensors and said substrate comprises a corresponding number of target images and said substrate comprises target images for imaging by said image sensors.

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14. An apparatus according to Claim 10 wherein said touch system comprises at least two opposing touch probes.

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15. An apparatus according to Claim 10 wherein said apparatus further comprises a calibration system, said optical systems and said calibration system cooperating to position said substrate mount along said y-axis and said dispensing device along said x-axis.

16. An apparatus according to Claim 15 wherein said calibration system comprises a locator device having a predetermined fixed target location and a camera acting in cooperation with said optical systems.

5 17. An apparatus according to Claim 10 wherein said substrate mount is adapted such that its orientation is adjusted to align said substrate along said y-axis as a result of input from said optical system for positioning said substrate mount and wherein said dispensing device is adapted such that its orientation is adjusted to align said dispensing device along said x-axis as a result of input from said optical system for  
10 positioning said dispensing device.

18. An apparatus according to Claim 10 further comprising a delivery device for delivering said substrate to said substrate mount, said delivery device having associated therewith a delivery device optical system for positioning said substrate to be  
15 within the field of view of the said support mount optical system.

19. An apparatus according to Claim 18 wherein said delivery device optical system comprises two or more image sensors and said substrate comprises a corresponding number of target images.

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20. A method comprising:  
(a) positioning a substrate along a y-axis by means of an optical system,  
(b) positioning a dispensing device along an x-axis by means of an optical system, said optical systems cooperating to position said substrate mount and said  
25 dispensing device relative to one another,  
(c) positioning said substrate and said dispensing device relative to one another along an orthogonal axis by means of at least one touch system, and  
(d) depositing a reagent for synthesizing a biopolymer on a surface of said substrate by means of said dispensing device.

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21. A method according to Claim 20 wherein said optical system for positioning said substrate mount comprises two or more image sensors and said substrate comprises a corresponding number of target images.

22. A method according to Claim 20 wherein said positioning of step (a) involves a calibration system, said optical systems and said calibration system cooperating to position said substrate mount along said y-axis and said dispensing device along said x-axis.

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23. A method according to Claim 22 wherein said calibration system comprises a locator device having a predetermined fixed target location and a camera acting in cooperation with said optical system.

10 24. A method according to Claim 23 wherein adjustments are made to the orientation of said substrate along said x-axis as a result of input from said optical system and wherein adjustments are made to the orientation of said dispensing device and said substrate mount along said y-axis as a result of input from said optical system.

15 25. A method according to Claim 20 wherein said system comprises touch probes that are aligned optically.

26. A method for synthesizing an array of biopolymers on a surface of a substrate, said method comprising, in multiple rounds of subunit additions, adding one or more polymer subunits at each of multiple feature locations on said surface to form one or more arrays on said surface, each round of subunit additions comprising:

20 (a) bringing said substrate and a dispensing system for dispensing said polymer subunits for the synthesis of said biopolymers into a dispensing position relative to said activated discrete sites on said surface wherein said substrate is positioned along a y-axis by means of an optical system and said dispensing system is positioned along an x-axis and said substrate mount and said dispensing system are positioned relative to one another by means of said optical systems and wherein said dispensing system is positioned along a z-axis by means of at least one touch system,

25 (b) dispensing said polymer subunits to said discrete sites, and

30 (c) removing said substrate and/or said dispensing system from said relative dispensing position.

27. A method according to Claim 26 wherein said optical system for positioning said substrate mount comprises two or more image sensors and said substrate comprises a corresponding number of target images.

5 28. A method according to Claim 26 wherein said positioning of step (a) involves a calibration system, said optical systems and said calibration system cooperating to position said substrate mount along said y-axis and said dispensing device along said x-axis.

10 29. A method according to Claim 28 wherein said calibration system comprises a locator device having a predetermined fixed target location and a camera acting in cooperation with said optical system.

15 30. A method according to Claim 29 wherein adjustments are made to the orientation of said substrate along said x-axis as a result of input from said optical system and wherein adjustments are made to the orientation of said dispensing device and said substrate mount along said y-axis as a result of input from said optical system.

20 31. A method according to Claim 26 wherein said touch system comprises at least two opposing touch probes and said touch probes are aligned optically.

32. A method according to Claim 26 wherein said biopolymers are polynucleotides or polypeptides.

25 33. A method according to claim 32 further comprising exposing the array to a sample and reading the array.

34. A method comprising forwarding data representing a result obtained from a reading of an array exposed according to the method of Claim 33.

30 35. A method comprising transmitting to a remote location data representing a result of an interrogation obtained by reading of an array exposed according to the method of Claim 33.

36. A method comprising receiving data representing a result of an interrogation obtained by reading of an array exposed according to the method of Claim 33.

5 37. A method for washing droplet dispensing nozzles to remove residual reagents for synthesizing biopolymers, said method comprising:

(a) sealingly engaging each head comprising said nozzles having said residual reagents therein with a receptacle containing a wash solution,

(b) flushing each of said nozzles with said wash solution,

10 (c) disengaging each of said nozzles from respective receptacles,

(d) engaging a surface comprising said nozzles with a wet wash pad, and

(e) engaging said surface with a dry pad.

15 38. A method according to Claim 37 further comprising repeating step (e) if residual wash solution is present.

39. A method according to Claim 37 wherein step (d) is performed by wiping said surface over said wash pad.

20 40. A method according to Claim 37 wherein step (e) is performed by wiping said surface over said dry pad.

41. An apparatus for washing droplet dispensing nozzles to remove residual reagents for synthesizing biopolymers, said apparatus comprising:

25 (a) a plurality of receptacles for sealingly engaging each head comprising said nozzles having said residual reagents therein, said receptacles containing a wash solution,

(b) a wet wash pad for engaging a surface comprising said nozzles, and

(c) a dry pad for engaging said surface, and

30 (d) a mechanism for moving said apparatus relative to said droplet dispensing nozzles such that said nozzles serially engage said plurality of receptacles, said wet wash pad and then said dry pad.

42. An apparatus according to Claim 41 wherein said plurality of receptacles, said wet wash pad and said dry pad are contained in a compartment in a housing.

43. An apparatus according to Claim 41 wherein said mechanism moves said  
5 apparatus transversely to said droplet dispensing nozzles.

44. An apparatus for loading reagents into a dispensing device, said  
apparatus comprising one or more reagent receptacles and a retractable cover disposed  
over said receptacles.

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45. An apparatus for washing a reagent dispensing device, said apparatus  
comprising one or more wet wash pads for wet washing a surface or a portion of the  
reagent dispensing device and one or more dry pads for dry wiping the reagent  
dispensing device.

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46. An apparatus comprising:

(a) a substrate mount for receiving a substrate,

(b) a dispensing device for dispensing reagents for synthesizing a  
biopolymer on a surface of said substrate, and

20 (c) a touch system for positioning said substrate and said dispensing device  
along a z-axis.

47. An apparatus according to Claim 46 further comprising an optical system  
for positioning said substrate mount along said y-axis and an optical system for  
25 positioning said dispensing device along said x-axis, said optical systems cooperating to  
position said substrate mount and said dispensing device relative to one another,  
wherein one of said substrate mount and said dispensing device is adapted for  
translation along a y-axis and for rotation about a central axis of the substrate mount that  
is parallel to a z-axis, and the other of said substrate mount and said dispensing device is  
30 adapted to move along an x-axis transversely to the direction of movement of said one.

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